Highlights
Environmental Management
Technology Innovation & Development

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

WHAT'S INSIDE

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Message from the Office of Technology Innovation and Development Director, Yvette Collazo

In 2010, we are building upon our past successes in Waste Processing, Soil and Groundwater, and Deactivation and Decommissioning, while also beginning a new program in Nuclear Materials Disposition within DOE-EM's new Office of Technology Innovation and Development.

I am excited about joining the new organization and committed to turning our plans into reality. Our efforts to promote collaboration, integration, and communication across DOE sites and the worldwide nuclear cleanup community are of key importance to the success of the EM Technology Innovation and Development Program. Our remaining technical problems represent significant challenges, and there is an ever-increasing need for transformational solutions to address them, while also achieving reductions in current baseline costs and schedules.

We look forward to working with DOE and Federal counterparts, national laboratories, universities, international colleagues, contractors, regulators, and stakeholders to achieve our goals.

New Office of Technology Innovation and Development Leads EM Applied Research and Technology Program

DOE's Office of Environmental Management's (EM) Applied Research and Technology Development and Deployment Program is now being managed by the new Office of Technology Innovation and Development (OTID), which was formed during the EM reorganization late last year. The overall goal of the OTID is to reduce the life-cycle resources required to clean up legacy nuclear waste and aging infrastructure. The program focuses research and development on new approaches and new technologies that can significantly reduce risks, costs, and schedules.

The Applied Research Technology Development and Deployment Program provides technical solutions where none exist, improved solutions that enhance safety and operating efficiency, and technical alternatives that reduce programmatic risks to technical baselines. For 2010, this is being accomplished through a high-risk, high-reward approach to research and development projects to remove barriers, reduce uncertainties, and leverage other investments by partners including national laboratories, the private sector, academia, and international entities.

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The Department has identified Nuclear Materials Disposition as a new Program Area in 2010, recognizing the increasing need to address technical challenges in the areas of spent nuclear fuel and challenging materials.

The Department has adopted an R&D framework built on the foundation of the National Academy of Science report issued in 2009, which provided recommendations supporting each of the key Program Areas for 2010:

- **Waste Processing** (retrieval and closure, alternative pretreatment, advanced unit operations and scaling, improved vitrification capacity, increased waste loadings)
- **Groundwater and Soil Remediation** (advanced simulation capabilities, advanced remediation technologies, treatment and cover system technologies, and performance of cementitious materials)
- **Nuclear Materials Disposition** (spent nuclear fuels packaging for disposal, disposal material, and component technologies; and storage and transportation technologies, challenging materials inventory characterization, and conditioning and disposal)
- **Deactivation and Decommissioning** (transformational characterization technologies, robotic systems, equipment removal, dismantlement, and closure).

The OTID Program Areas align with EM's overall priorities of:

- Reducing risk while maximizing compliance with regulatory commitments
- Completing the capability to disposition tank waste and nuclear materials
- Consolidating and preparing for disposal of surplus plutonium and spent nuclear fuel
- Continued shipment of transuranic waste to the Waste Isolation Pilot Plant
- High-priority soil and groundwater remediation
- Footprint reduction.

To accomplish the above goals, OTID provides

- the highest level of interdisciplinary engineering consultation, guidance, expertise, technical review, and assistance to EM
- development and implementation of engineering concepts, practices, and advanced technologies for improvement of design, construction, and implementation of cleanup systems
- assistance to promote cross-site integration, standardizing best technical practices, and sharing of lessons learned.

For 2010, the Department has developed an integrated program with investment in high-return research and technology development with the goal of timely insertion of mature technologies to meet site cleanup needs.

On March 1, 2010, OTID will submit its Annual Report to Congress documenting the programmatic plans for technology development to support the EM cleanup program in 2010.

Meeting DOE's Challenge of Mercury in the Environment

A technical summit sponsored by DOE EM's Office of Groundwater and Soil Remediation advanced knowledge and technologies for addressing the challenges of cleaning up mercury in the environment, while also promoting collaboration among scientists and engineers across the United States.

Mercury is a significant contaminant of concern at several DOE sites, including the Y-12 National Security Complex (Y-12) in Oak Ridge, TN. During the 1950s and early 1960s, mercury was used at Y-12 as part of a lithium isotope separation process. Large quantities of mercury were released to the environment, resulting in contamination of buildings, sewer lines, soils, sediments, groundwater, and surface water. The complexities of mercury's behavior in the environment result in significant challenges related to its characterization, remediation, and prediction.

The technical summit *Mercury Challenges in the Environment,* convened on October 22 and 23, 2009, at Vanderbilt University in Nashville, TN, brought together more than 70 experts from state and federal regulatory agencies, other government agencies, national laboratories, academia, industry, and consulting to exchange information on recent research, field application, and policy developments. A variety of topics were discussed, including:

- mercury-related regulatory and public issues
- mercury at the DOE Oak Ridge site, including history of use, mercury in fish, and past and planned remediation in creeks and storm sewer systems
- mechanisms and controls on mercury biogeochemistry and transformation
- strategies for reducing formation of methylmercury, a toxic and bioaccumulating mercury species, in the environment
- ecological risk assessment
- site conceptual modeling of mercury
- modeling of mercury transport pathways and associated risk at Oak Ridge
- innovative characterization and remediation technologies for mercury in sediments, soils, and water.

Sustained communication with world-class experts and responsiveness to emerging technical needs are essential to the success of the Groundwater and Soil Remediation Program, as it addresses mercury cleanup issues across the DOE Complex.

The meeting agenda and many of the presentations are posted on the Groundwater and Soil Remediation website at **http://www.em.doe.gov/EM20Pages/EM20ReferencePage.aspx** (under "Workshops and Events"). Follow-up meetings and discussions are being held with collaborators from the Oak Ridge Site, the national laboratories, DuPont, and other interested organizations. Research needs and data gaps identified by these partners and other summit participants are helping to guide DOE's applied research program. Sustained communication with world-class experts and responsiveness to emerging technical needs are essential to the success of the Groundwater and Soil Remediation Program, as it addresses mercury cleanup issues across the DOE Complex.

Mercury Summit participants exchange information during lunch.

New Tank Waste Cleaning Technologies Enable Efficient High-Level Waste Tank Closure

Last year, DOE Office of Engineering and Technology demonstrated two new technologies to clean high-level waste tanks to remove sufficient radioactive waste to meet regulatory requirements for closure. A combination of cleaning and mixing methods is used to remove the radioactive waste from the tanks. First, a large volume of the waste is removed using physical methods, such as jetting. Second, chemical cleaning is performed to remove residual radioactivity. A new, environmentally friendly and recyclable cleaning solution was successfully tested by Savannah River National Laboratory researchers last year, and a new system to mix the cleaning solution with the waste in the tank was developed and demonstrated by NuVision Engineering to improve performance of the cleaning solution. The new mixing system is based upon power fluidics technology that has been broadly applied in the United Kingdom for nuclear waste handling.

The traditional method of chemically cleaning the tanks produces a large volume of secondary waste to be treated. The new chemical cleaning process, called Enhanced Chemical Cleaning (ECC), uses a dilute oxalic acid (1%) that can be recycled. When combined with the pulse jet low-level mixing system, the amount of secondary waste generated during the cleaning process is greatly reduced and removal of residual radioactivity is improved.

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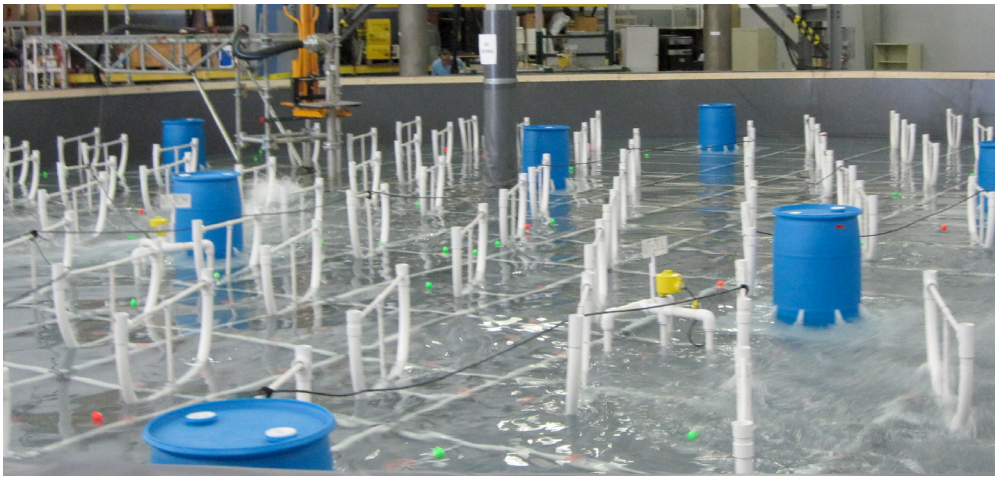
To ensure improved performance with the ECC technology, a better mixing system was needed to maximize contact time between the cleaning solution and the waste remaining in the tank, while also minimizing the amount of acid required for cleaning. Two of the key challenges were an ability to operate at very low levels of waste in the tank and to clean tanks that contain obstacles to flow throughout.

Because the power fluidic low-level mixing system combined with ECC is planned to support closure of Savannah River Site (SRS) Tank 8 in the F-Tank Farm, key performance criteria for the mixing demonstration were established by SRS staff. The demonstration involved design, fabrication, and demonstration of a power



Demonstration of the Low Level Power Fluidic System at the NuVision Engineering Test Facility in North Carolina.

fluidic low-level mixing system at 80% scale in a 61-foot diameter test tank. Internal cooling coils, columns, obstructions, and limited-access locations replicated conditions in a Type I tank at SRS.

A number of test campaigns were conducted at the NuVision Engineering test facility in North Carolina to evaluate:

- impact of process parameters on system performance
- impact of operational parameters on system performance
- maximum, minimum, and average bulk fluid velocity.

The mixing system demonstration met or exceeded the key performance criteria set by Savannah River staff, while

- satisfying the design constraints of the number and location of available risers
- exceeding the primary criterion to achieve 0.2 ft/s velocity at any location in the tank, and
- nearly meeting the stretch goal to achieve 2 ft/s velocity at any location in the tank to address removal of waste in mounds.

The mixing system was operated with fluid levels of 12 and 18 inches, as opposed to a traditional mixer pump that ceases operation when the tank fluid level is less than 30 inches. The demonstration established that system modifications are not required unless performance criteria are revised. Demonstration results provided the necessary design data for a deployable system for Tank 8 at SRS.

Further optimization may not be required, but is available. Future work could include additional system configurations (e.g., impact of different nozzle diameters, performance at lower liquid depths, or additional available risers).

Precision Models Aid Deactivation & Decommissioning

Use of the Savannah River National Laboratory's (SRNL) computer-produced scale replicas of the SRS reactor buildings is saving time and money as the Site plans final disposition of the reactor facilities.

The SRS R and P Reactors were built in the early 1950s and shut down in 1964 and 1988, respectively. Using stimulus funding for cleanup of SRS, the reactors are scheduled for deactivation and decommissioning (D&D) using an approach called In-Situ Decommissioning. Below-grade areas will be stabilized by filling them with specially designed grout. Portions of the above-ground facility will be demolished, while other portions will remain standing, sealed against access by humans or animals, to serve as a protective cover for grout-stabilized below-grade areas. Grouting of the below-ground areas calls for a precise understanding of their rooms, walls, and other structural elements.

Originally, SRS D&D personnel asked SRNL to use its rapid prototyping capabilities to create a scale model of one canal inside the R Reactor complex to help them visualize how to approach filling it with grout. Based on the usefulness of that model, they requested an 8-foot long, 4-foot wide model of the entire underground portion of the R Reactor complex.

Before beginning production of the three-dimensional models, the SRNL team creates computer-assisted design (CAD) models from the historical prints and drawings of the facilities' construction to obtain the exact dimensions – a fascinating and time-consuming history project in itself. These CAD models are useful for calculating the volume of grout needed and planning grout placement strategy, while the three-dimensional objects allow a greater understanding of the space and where to place the pipelines for delivery of the grout.

The models include all the reactor facilities' structural elements, such as walls and stairwells, and every opening two inches in diameter or larger. The model of the major facilities is at a 1/96th scale; a model of the reactor vessel itself is at 1/8th scale.

Rapid prototyping automates the translation of CAD drawings into three-dimensional models. The equipment used in this project, Stratasys Fused Deposition Modeling®, is essentially a high-tech hot glue gun. Plastic wire is fed to a nozzle, which is controlled by a computer that reads the CAD documents. The nozzle melts the plastic and extrudes it very precisely.

SRNL is now working on a model of the P Reactor Disassembly Basin and models of additional facilities that are scheduled for D&D.

The components of the Savannah River Site reactor facilities model, manufactured by rapid prototyping equipment, were used to fabricate the first floor and below-grade portions of the buildings.

Technical Evaluation of Soil Remediation Alternatives at Lawrence Livermore National Laboratory Site 300

A technical review requested by the DOE Office of Environmental Management provided useful recommendations for addressing technical and cost uncertainties in soil remediation activities at Building 812 at Site 300 of Lawrence Livermore National Laboratory.

The expert technical review team examined the alternatives proposed in the draft Remedial Investigation/Feasibility Study (RI/FS) for addressing depleted uranium contamination in soil, including excavation with off-site disposal, soil washing, solidification and consolidation, or on-site disposal.

The team made the following recommendations:

- The following areas of technical and cost uncertainty be resolved prior to the final selection of a preferred remedial alternative:
  - spatial distribution of depleted uranium contamination;
  - chemical/physical form of depleted uranium;
  - revised cost estimates for remedial alternatives.
- A phased approach be implemented to reduce these uncertainties through the following:
  - systematic sampling of surface soil activity on a grid with a high-purity germanium detector;
  - vertical screening using a sodium iodide detector to determine contaminant distribution with depth; this profile of contaminant concentrations would guide the strategy for excavation; and,
  - chemical and physical characterization of depleted uranium to understand dominant phases, leachability, and bioavailability.
- Risk calculations be revised after site characterization, based on reclassification of land use. Recommended risk assessment revisions involve reasonable maximum exposure scenario for the industrial worker, exposure value for the deer mouse, bioaccumulation factors for vegetation and invertebrates, and use of actual data for air particulate calculations.
- Soil washing, one of the alternatives considered in the RI/FS and recommended by regulators for further study, should not be considered, because final remediation levels would have to be significantly higher for soil washing to be a preferred alternative.
- A phased approach be implemented for the remediation, which includes portions of the original RI/FS identified technologies (excavation of source material at the firing table, canyon alluvium, and hot spots on steep slopes) followed by physical treatment of the excavated material to reduce the volume that requires off-site disposal, pending results of the recommendations above.

Technical Assistance Team touring the B812 Firing Table Site.

The team noted that the site should consider the ecosystem impacts due to excavation on steep slopes to identify areas primarily impacted by airborne contamination, reducing volume of excavated soil. The team felt that ecosystem recovery may occur more quickly if low levels of residual contamination are left in place and monitored.

Advanced Subsurface Computing for Environmental Remediation (ASCEM) Kickoff Meeting Held

The ASCEM initiative was kicked off with a meeting of 70 principal participants and managers at Lawrence Berkeley National Laboratory on January 20-21, 2010. ASCEM will develop state-of-the-art scientific tools and approaches for understanding and predicting contaminant fate and transport in natural and engineered systems. The modular and open-source high-performance computing tools will facilitate integrated approaches to modeling and site characterization that enable robust and standardized assessments of performance and risk for EM cleanup and closure activities. ASCEM will help EM better estimate cleanup times and costs and reduce uncertainties and risks. Discussions involved definition of work scope and integration with other programs within OTID, Office of Science, Office of Nuclear Energy, the Performance Assessment Community of Practice, and other national and international programs. Management from OTID, EM's Office of Environmental Compliance, the DOE Carlsbad Field Office, and management and technical leads from the multi-laboratory team from Los Alamos, Lawrence Berkeley, Pacific Northwest, Oak Ridge, Savannah River, Lawrence Livermore, Argonne, and Idaho national laboratories, and Florida International University attended the meeting.

ASCEM will help EM better estimate cleanup times and costs and reduce uncertainties and risks.

An implementation plan for ASCEM is being prepared. Key program deliverables for FY10 include a set of requirement documents due in March and design documents due in June. An independent technical review is planned for Spring 2010 to evaluate plans submitted by the multi-laboratory team. Over the next decade the ASCEM toolset will be:

- developed by leveraging the latest environmental research and high- performance computing technologies
- demonstrated with field testing and observational data, and
- deployed to DOE sites to support the risk reduction and program acceleration goals of the EM cleanup program.

See http://crd.lbl.gov/conf/ascem20100120/index.html for more information.

Nuclear Materials Status Meeting to be Held in March in Idaho

The Office of Nuclear Materials Disposition and the National Spent Nuclear Fuel Program will conduct their annual status meeting in Idaho Falls, March 24-25, 2010. The agenda will feature site-based presentations on spent nuclear fuel and high-level waste that describe the current safety basis and identify potential issues for longer-term storage. Presently, the technical bases for very long-term (beyond about 60 years) wet and dry storage of used fuel have not been firmly established and a panel of DOE and commercial representatives will discuss the future of extended storage. Representatives from the General Accounting Office will discuss their recent report on Yucca Mountain alternatives and staff from the Office of Nuclear Energy will describe the newly-formed Used Fuel Disposition office. For more information, please contact Nancy Buschman at 301-903-3679 or nancy.buschman@em.doe.gov.

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